Group D-1 | Optimizing embodied and operational energy and carbon footprints of buildings in current and future scenarios.

COA 〉SHOWCASE

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As climate change continues to pose significant challenges, redefining building design for enhanced lifecycle efficiency has become imperative. The research rigorously investigates how a spectrum of optimization objectives and varying climatic conditions shape the development of optimal building configurations. By exploring these factors, the study aims to illuminate the intricate interplay between design choices and environmental variables, thereby providing insights that enhance the resilience and sustainability of future building practices. This paper presents a comprehensive framework that merges genetic algorithms with simulation techniques, leveraging the Energy Plus platform and incorporating embodied impact databases, including energy and carbon emission factors. This integrated approach enables a thorough evaluation and optimization of both operational and embodied energy, as well as carbon footprints, while navigating the complexities of the energy-carbon relationship under current and future climatic scenarios. The methodology is applied to a representative office building model in two distinct optimization phases. The first phase emphasizes the trade-offs between operational and embodied energy, whereas the second phase focuses on optimizing the interplay between operational and embodied carbon emissions. Under current weather conditions, the first phase achieves a notable 34.66% reduction in total primary energy consumption compared to the original design. In the second phase, the framework results in a 29.29% decrease in the carbon footprint. When future weather scenarios are examined, the first phase yields a 33.94% reduction in total primary energy use, followed by a 23.03% decrease in total carbon emissions in the second phase. These findings illustrate the framework effectiveness in promoting energy-efficient and sustainable building designs in the face of evolving climatic challenges.